



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>G09F</b>	<b>A2</b>	(11) International Publication Number: <b>WO 99/30304</b> (43) International Publication Date: 17 June 1999 (17.06.99)
<p>(21) International Application Number: PCT/US98/26111</p> <p>(22) International Filing Date: 9 December 1998 (09.12.98)</p> <p>(30) Priority Data: 08/988,011 10 December 1997 (10.12.97) US</p> <p>(71) Applicant: PHILLIPS PLASTICS CORPORATION [US/US]; Seven Long Lake Drive, Phillips, WI 54555 (US).</p> <p>(72) Inventors: PETERSON, Francis; 807 College Street, Prescott, WI 54021 (US). WALSH, David; 324 Townsvalley Road, River Falls, WI 54022 (US).</p> <p>(74) Agents: LEVY, Elizabeth, A. et al.; Lappin &amp; Kusmer LLP, 200 State Street, Boston, MA 02109 (US).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>Without international search report and to be republished upon receipt of that report.</i></p>
<p>(54) Title: DISPLAY DEVICE AND METHOD THEREFOR</p>		
<p>(57) Abstract</p> <p>An electroluminescent display includes thin conductive strips on a phosphor deposited area. One aspect of the invention is directed to a device including a dielectric carrier supporting a first conductive bus connecting to first conductors and a second conductive bus connecting to second conductors. The first and second conductors are arranged in close proximity to one another, so that a phosphor-based carrier can be located therebetween to permit an electric field set up by a voltage applied between the first and second conductors to generate light via the phosphors. A dielectric layer disposed between the conductors enhances the brightness of the light generated. The electroluminescent display can be incorporated as part of a mirror or liquid crystal device.</p>		

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NI	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## DISPLAY DEVICE AND METHOD THEREFOR

This application is a Continuation-in-Part of U.S. Patent Application Serial No.08/847,197, filed May 1, 1997.

### Field of the Invention

5

The present invention relates to electronically-controlled displays that can be manufactured as parts of other functional structures. More particularly, the present invention relates to electronic displays, including electroluminescent displays, that can be manufactured as parts of other functional structures.

10

### Background of the Invention

Displays are implemented using a variety of technology areas for use in a wide variety of applications. The technology areas span from the cathode ray tube (CRT), to various field emission display technologies, to light-emitting diode technologies, etc. The uses and applications of displays are without limit. For example, consider some display devices, such as with alphanumeric displays and computer-type display screens, whose primary purpose is to display information, and other display devices that serve secondary functions, such as backlighting user access points or controls. For many of these applications, the size and manufacturability of the display devices are major concerns.

As an example, electroluminescence is one of several popular display technologies that have been used in view of size constraints. Common uses of electroluminescence include, among other uses, backlighting watches and display screens in certain laptop and notebook computers. Electroluminescence technology is conventionally implemented using phosphor material sandwiched between two conductive layers. One of the conductive layers is typically a transparent material, such as mylar, that is coated with a transparent conductor, such as indium tin oxide.

When a high voltage of alternating polarity is applied to the respective conductive layers, an electric field is created that excites the phosphor.

Manufacturing devices using displays of this type are cumbersome. In the design of a typical application, at least a three-layer electroluminescent display structure is cooperatively arranged nearby another circuit. This neighboring circuit is arranged to avoid blocking the electroluminescent light, and the electroluminescent display structure is arranged to avoid interfering with the functionality of the neighboring circuit. For many applications, especially those requiring significant generation of light in compact areas, this cooperative arrangement is not practicable.

Accordingly, many applications require displays that can be implemented in small areas while avoiding the disadvantages discussed above.

## 15 Summary of the Invention

One aspect of the present invention is directed to an electroluminescent display device. The display device includes first and second conductive buses adjacent to an electroluminescent medium on a dielectric carrier. The first and second conductive buses have at least one first conductor and at least one second conductor, respectively. These conductors are arranged in close proximity to one another, and they are secured over and supported by the dielectric carrier. The electroluminescent medium is located proximate to the first and second conductors to permit an electric field set up by a voltage applied between the first and second conductors to generate light. In more specific embodiments, the medium is phosphor-based and polymer-based, respectively.

Another aspect of the present invention is directed to a method for manufacturing the above-described electroluminescent display device. According to one embodiment, the method provides the manufacture of a electroluminescent display device on a dielectric carrier. The method includes: applying a first

conductive bus having at least one first conductor, and a second conductive bus having at least one second conductor, arranged in close proximity to said at least one first conductor, over the dielectric carrier and forming at least one area therebetween; and depositing a phosphor-based carrier in said at least one area between the first and second conductors, the first and second conductors arranged to excite the phosphors and generate light therefrom.

Another aspect of the present invention is directed to improving the brightness of the device or to improving the method, as described above, by applying a nonconductive material, such as DuPont 7153-type dielectric composition, over the patterned conductive buses, or by using another such material to increase capacitance between the alternately arranged conductors. It has been discovered that such implementation substantially increases the brightness. In a particular application, the brightness has been doubled by using a thin layer of this nonconductive material applied directly over the entire patterned conductive areas. Other materials of this type, *e.g.*, other dielectric compositions, can be used as well.

According to another embodiment of the present invention, an electroluminescent display device is formed on a mirror having a metallized surface. The metallized surface is selectively etched to define a first conductive bus having at least one first conductor and a second conductive bus having at least one second conductor arranged in close proximity to the at least one first conductor. A phosphor-based carrier including phosphor therein is located proximate to the first and second conductors to permit an electric field set up by a voltage applied between the first and second conductors to generate light via the phosphor. The mirror can form part of a liquid crystal device.

Another aspect of the present invention is directed to a method for manufacturing an electroluminescent display device on a mirror having a metallized surface. The metallized surface is selectively etched, defining a first conductive bus having at least one first conductor and a second conductive bus having at least one second conductor in close proximity to the at least one first conductor and forming at least one area between the at least one first conductor and the at least one second conductor. A phosphor-based carrier having a phosphor is deposited in the at least one area. The first and second conductors are

arranged to excite the phosphor and generate light therefrom in response to an applied voltage.

5           The above summary of the present invention is not intended to describe each disclosed embodiment, or every implementation, of the present invention. The figures and the detailed description that follow more particularly exemplify these embodiments.

#### Brief Description of the Drawings

10

Other aspects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

15

Fig. 1 is an exaggerated, perspective view of an electroluminescent display device, according to one embodiment of the present invention;

20

Figs. 2a, 2b, and 2c illustrate respective top views of three different conductor layouts for exciting phosphor in an electroluminescent display device, and Fig. 2d illustrates a perspective view of another conductor layout for exciting phosphor in an electroluminescent display device, each of the respective layouts being in accordance with the present invention;

25

Fig. 3 is a side view of a backlit remote control device, according to a particular application and embodiment of the present invention, employing an electroluminescent display consistent with the illustration of Fig. 1;

30

Fig. 4 is a top view of an electroluminescent display arranged as part of a combination key and integrated circuit, according to a particular application and embodiment of the present invention;

35

Fig. 5 is a view of a backlit button configured as part of a set of buttons and an employing electroluminescent display consistent with the illustration of Fig. 1, all of which is in accordance with a particular application and embodiment of the present invention; and

Fig. 6 is a view of an electroluminescent display arranged as part of a mirror,

according to a particular application and embodiment of the present invention.

While the invention is susceptible to various modifications and alternative forms,  
specifics thereof have been shown by way of example in the drawings and will be described  
5 in detail. It should be understood, however, that the intention is not to limit the invention to  
the particular embodiment described. On the contrary, the intention is to cover all  
modifications, equivalents, and alternatives falling within the spirit and scope of the  
invention as defined by the appended claims.

## 10 Detailed Description

The present invention is believed to be useful for a variety of applications requiring  
or benefitting from display devices that can be implemented in relatively small areas. While  
the present invention is not intended to be so limited, an appreciation of the present  
15 invention is best obtained through a discussion of particular example applications, including  
an electroluminescent display device constructed in accordance with a particular  
embodiment of the present invention.

One important aspect of the present invention is directed to the implementation of  
20 devices including an electroluminescent display, for example, as illustrated in the  
exaggerated, perspective view of the display construction 10 of Fig. 1. The display  
construction 10 includes first and second conductive buses 12 and 14 including respective  
first and second display runners or conductors 16 and 18. By locating the conductors 16 and  
18 in close proximity to one another and disposing a phosphor-based carrier 20 between the  
25 two conductors 16 and 18, a conventional electroluminescent inverter circuit 24 can be  
connected across the two buses 12 and 14 to set up an electric field and generate light via  
the phosphor material in the carrier. In the particular example illustrated, the display  
generates light along a single line between the conductors 16 and 18. It will be understood  
that the "buses" may be as illustrated as a wider portion of the conductor extending from the  
30 inverter terminal or may be constructed and arranged as merely an indistinguishable and  
continuous part of the conductor(s) emanating therefrom.

By extending the phosphor-based carrier 20 so that it resides between other  
conductors and/or between the bus conductors 12 and 14, displays in non-linear shapes and

different sizes can be realized. As illustrated in the embodiment of Fig. 2a, for example, the conductors 16 and 18 of Fig. 1 are respectively replaced or supplemented by a plurality of first conductors 16a through 16k and a plurality of second conductors 18a through 18k. The first conductors 16a through 16k are interleaved with the second conductors 18a through 18k, to create a multitude (eleven in the example illustration) of phosphor-energizable areas, one such area in the proximity of each opposing pair (e.g., 16a and 18a) of conductors. Fig. 2b provides another example configuration wherein the bus conductors 12 and 14 are widened to increase the current-carrying capability of the buses and wherein the conductors, generally designated as 16 and 18, are interleaved and aligned in a zig-zag pattern for an esthetically-specific display application. Other shapes, including, but not limited to, curvilinear and non-linear shapes, can also be implemented as supplements or alternatives to the above conductor constructions.

According to another important aspect of the present invention, Fig. 2c illustrates a configuration wherein the conductors 16 and 18 are serrated to form energy-generating tips. As the polarity of the energy between opposing conductors changes, the changing E-field at the opposing tips is concentrated, thereby enhancing brightness. For enhanced lighting generated at the phosphor-energizable areas defined by the opposing conductors, the frequency of the tips per unit of linear measure is increased.

According to yet another important aspect of the present invention, Fig. 2d illustrates a configuration wherein a fingered conductor 17 and a polarity-opposing graphic conductor 19 are separated by a dielectric 21, such as a thin sheet of mylar. The conductor 17 is covered by (or, alternatively, covers) a layer of phosphor-based material. The conductor 17, which may include a finger-extending bus portion 17a, includes separated fingers 17b- 17q arranged over the graphic conductor 19. As the polarity of the energy between the conductors 17 and 19 changes, the changing E-field at the opposing tips illuminates the shape of the graphic conductor 19 on the side of the clear dielectric 21 carrying the conductor 17. The conductors 17, 19 and the phosphor-based material may be applied as described herein in connection with Figs. 2a, 2b and 2c.

In a more specific embodiment consistent with the approach of Fig. 2d, the graphic conductor 19 is implemented as separated conductors with each separated conductor carrying the opposing charge in an alternative manner. A control circuit, such as a



programmed microprocessor and selectable encoder (or functional equivalent such as an ASIC), passes the opposing charge to each of the separated conductors to illuminate selected portions of the desired graphic display.

5           Among other benefits and advantages, these above-disclosed embodiments permit a relatively inexpensive and straightforward manufacture of displays on any of a variety of dielectric carriers 22 and, where beneficial, as an integral part of other functional devices. Referring to Fig. 3, for example, a battery-operated remote control 28 includes, as integral parts, an electronic display 30, such as illustrated above, and a conventional switch circuit. 10       The electronic display 30 is printed on the control-access side of a printed circuit board (PCB) 32. The PCB 32 carries conventional components (not shown in Fig. 3) including circuit-connecting conductors, a signal transmitter, and a control circuit. The switch circuit includes a conductor-carrying depressor 34 opposite the PCB 32 and wire-terminating contacts 36 on the PCB adjacent the electronic display 30. The depressor 34 includes at least 15       a portion that is transparent to permit passage of light generated by the electronic display. The electroluminescent inverter is optionally arranged as part of the control circuit carried by the PCB 32.

          A battery circuit 24a is used, selectively or as required, to energize the 20       electroluminescent inverter (24b of Fig. 3). For example, upon first engagement of any of the depressors of the remote control device, the control circuit switches power on to the electroluminescent inverter and maintains such power for a predetermined period of time to permit the user to distinguish the keys from one another. In this mode, the control circuit includes a conventional firmware- or hardware-implemented debounce circuit to prevent 25       erroneous readings of the switches as can be caused by the user inadvertently striking the same switch repeatedly or multiple switches at about the same time.

          Fig. 4 illustrates a battery-operated remote control key device 48 with integral parts including electronic displays 51a, 51b, 51c and 51d for backlighting associated switch 30       circuits, the wire-terminating contacts of which are designated 54a, 54b, 54c and 54d. Each of the electronic displays 51a, 51b, 51c and 51d are implemented on the surface side of an integrated-circuit (chip) and configured, for example, as indicated above in connection with Fig. 2a, 2b or 2c.

The battery circuit 24a for this implementation can be used selectively in response to engagement of a mechanical conductor. For example, rotation of the metallic portion 66 of the key device 48 can be used to short a pair of terminals 70 and, in turn, inform the control circuit 60 that the electroluminescent inverter 24b is to be energized for a predetermined period of time. Alternatively, a user can depress a conductive, friction-fitting, slidable post 74 to provide the same input as rotating the key of the control circuit 60. As another alternative, or in addition, first engagement of any of the depressor portions of the switch circuit can inform the control circuit of the need to energize for the designated period of time, as described above in connection with Fig. 3.

Fig. 5 illustrates a portion of another remote control device having a plurality of hinged depressors 84 arranged in parallel and as part of an overall molded plastic unit 80. The remote control device of Fig. 5 is similar to the device of Fig. 4 in terms of the display and switch construction and general electrical operation. The remote control device of Fig. 5, however, includes an electroluminescent display 86 driven remotely from a control circuit having a driver providing (not shown in Fig. 5) energy to buses 87 and 88. These buses 87 and 88 are printed as conductive strips along two arms 89 and 90 of the molded plastic unit 80. The two arms 89 and 90 also carry buses 91 and 92 which connect to terminal ends 94 of a conventional switch circuit. In addition to carrying the buses (or conductors) to a control circuit terminal 96, the two arms 89 and 90 serve as a hinge to permit the switch end of the molded plastic unit 80 to freely move upon engagement into the unshown conductive portion of the switch for shorting the terminal ends 94 and informing the control circuit of the engagement. The electroluminescent display 86 is activated as described above in connection with Figs. 3 and 4 or, depending on the application, in response to another condition. For example, when used as a driver control panel in an automobile application, backlighting for depressors of the molded plastic unit 80 can be activated in response to opening the vehicle door, the keys being inserted into the ignition slot and/or engine start-up.

In each of the above remote control devices, the control circuit is implemented in a form that best suits the application. Some more sophisticated applications may require a program-based control circuit, such as a microprocessor or an ASIC (application-specific integrated circuit). For other applications, the control circuit may be implemented using conventional discrete analog and/or digital logic, such as pull-up resistors, diodes and wired-

OR type circuitry. For the above implementations in which a transmitter is being used, the transmitter type may also be selected and/or designed to meet the needs of the specific application. The inverter is also application-dependent. Included among the many inverter manufacturers are Motorola and NEC.

5

According to yet another aspect of the present invention, the electroluminescent display is manufactured by first applying the display conductors along with the switch conductors and buses where applicable. This is accomplished, *e.g.*, by screen printing the conductors on, or etch-removing a previously-applied conductive layer from, a dielectric surface. The dielectric surface may be any of a number of different types of substantially nonconducting surfaces, including but not limited to the protective housing of an IC, mylar, paper or virtually any type of plastic. Over the conductors, a phosphor-based carrier is deposited so as to cover the area or areas between the first and second conductors carrying the drive signals from the electroluminescent inverter. Alternatively, the phosphor-based carrier is deposited first, followed by application of the conductors.

10

15

The plastic components, for example, used as supportive outer housings for the structures of Figs. 3-5, are manufactured using conventional techniques. One such technique involves applying any needed graphics to the exposed side of a sheet of mylar, securing the conductors to the back side of the mylar as described above, forming the mylar as required by the application, cutting away and discarding the unused portion of the mylar, placing the remaining portion of the mylar into a mold and injecting plastic into the mold and onto the back side of the mylar.

20

25

Another aspect of the present invention is directed to improving the brightness of the device or as provided through the method, as described above, by applying a nonconductive material, such as DuPont 7153-type dielectric composition, over the patterned conductive buses, or by using another such material to increase capacitance between the alternately arranged conductors. It has been discovered that such implementation substantially increases the brightness. In a particular application, the brightness has been doubled by using a thin layer of a DuPont 7153-type nonconductive material applied directly over the entire patterned conductive areas.

30

According to a particular embodiment of the present invention, illustrated in Fig. 6,

an electroluminescent display is incorporated into a mirror 300. The mirror 300 has a metallized surface 302, on which a pattern of conductive traces is created using, for example, a laser (not shown) to etch the surface 302. Etching the surface 302 removes selected portions of the metallic coating, thus creating non-conductive areas. Those portions of the metallized surface 302 that are not etched away form conductive traces, *e.g.*, bus conductors 306 and 308. A phosphor-based carrier 304 is applied on the metallized surface 302 between bus conductors 306 and 308 and/or between other conductors. A dielectric coating, such as DuPont 7153-type dielectric composition, is optionally applied to the metallized surface 302 before applying the phosphor-based carrier 304. In certain applications, it might be desirable to use a dielectric composition with different properties, *e.g.*, dielectric strength and/or dielectric constant. The desired dielectric strength depends on, for example, the separation between the conductors and the magnitude of the voltage applied to the conductors.

In the example embodiment illustrated in Fig. 6, a plurality of first conductors 310a-310f and a plurality of second conductors 312a-312f are interleaved to create phosphor-energizable areas, one such area in the proximity of an opposing pair of conductors, *e.g.*, conductors 310a and 312a. When an electric field is set up between such an opposing pair of conductors, a corresponding phosphor-energizable area emits light. This emitted light is visible through the front surface (not shown) of the mirror 300. It should be understood that patterns other than that illustrated in Fig. 6 can be created on the metallized surface 302, including, but not limited to, curvilinear and nonlinear patterns. For example, patterns can be created that are particularly useful for use in indicators, warnings, or other display types integrated into the mirror 300. Alternatively, light shapes may be designed by selectively distributing the phosphor so that only selected areas of the conductors emit light. This can be advantageous in a number of applications, for example, those in which high volumes of structures including the traces are available for processing with phosphor.

According to a particular embodiment of the present invention, a lamp can be incorporated as part of a liquid crystal display (LCD) to provide an integrated backlight. This can be done by incorporating the lamp on the LCD's translector to manufacture the two buses or conductors with ITO (indium tin oxide) etched directly on the back of the LCD.

According to yet another embodiment of the present invention, the conductive buses can be implemented using nonmetallic material, such as indium tin oxide. This aspect of the present invention is applicable to each of the various embodiments disclosed herein.

5 Further, in applications where transparency throughout is desirable, a transparent ITO is effective in this regard.

According to another aspect of the present invention, an electroluminescent display is incorporated into a conventional electroluminescent polymer, such as implemented using the following formula:[to be supplied by the inventors], available from Uniax Corp. of Santa  
10 Barbara, California.

It will be apparent to those skilled in the art that various modifications and variations can be made to the embodiments illustrated herein without departing from the scope or spirit of the invention. Such modifications and variations do not depart from the  
15 true scope and spirit of the invention which is set forth by the following claims.

## WHAT IS CLAIMED IS:

1. An electroluminescent display device, comprising:  
a dielectric carrier;  
5 a first conductive bus having at least one first conductor and a second conductive bus having at least one second conductor arranged in close proximity to said at least one first conductor, the first and second conductors secured over and supported by the dielectric carrier; and  
an electroluminescent medium located proximate to the first and second conductors  
10 to permit an electric field set up by a voltage applied between the first and second conductors to generate light via the electroluminescent medium.
2. An electroluminescent display device, according to claim 1, wherein the first conductor is one of a plurality of conductors connected to the first conductive bus and further  
15 including a dielectric layer disposed between the conductors.
3. An electroluminescent display device, according to claim 2, wherein the second conductor is one of a plurality of conductors connected to the second conductive bus, and wherein the plurality of conductors connected to the first conductive bus and the plurality of  
20 conductors connected to the second conductive bus are interleaved to form a plurality of light generating areas, each area being defined by a first conductor and a second conductor.
4. An electroluminescent display device, according to claim 1, wherein the first and second conductors are secured over the planar surface by at least one of the following:  
25 removing excess conductive material from a previously applied conductive layer, screen printing a conductive medium, and selectively sputtering a conductive medium.
5. An electroluminescent display device, according to claim 1, wherein the first and second conductors are secured over the planar surface by a single application of screen  
30 printing.
6. An electroluminescent display device, according to claim 1, wherein the dielectric carrier includes at least one of the following: a back of an integrated circuit, paper, mylar, plastic, ceramic, and a metallized surface of a mirror.

35

7. An electroluminescent display device, according to claim 1, wherein the dielectric carrier is formed to fit a contoured surface.
- 5 8. An electroluminescent display device, according to claim 1, wherein the dielectric carrier includes an elongated extension supporting the first bus and a separate conductor electrically communicating with a circuit other than either of the first and second buses.
- 10 9. An electroluminescent display device, according to claim 8, further including a switch circuit arranged to be engaged via an at least partially transparent cover piece, the separate conductor electrically communicating with the switch circuit.
- 15 10. An electroluminescent display device, according to claim 1, further including a switch circuit arranged to be engaged via an at least partially transparent cover piece.
- 20 11. An electroluminescent display device, according to claim 1, wherein the dielectric carrier includes an elongated extension supporting the first bus and a conductor electrically communicating with an external circuit.
- 25 12. An electroluminescent display device, according to claim 1, wherein one of the first and second conductors electrically communicates with an external circuit.
- 30 13. An electroluminescent display device, according to claim 12, wherein said one of the first and second conductors is common.
14. An electroluminescent display device, according to claim 1, further including a substrate supporting the dielectric carrier.
15. An electroluminescent display device, according to claim 14, wherein the substrate is a housing for an integrated circuit.
16. An electroluminescent display device, according to claim 15, wherein the integrated circuit includes an electroluminescent display driver electrically coupled to and driving the electroluminescent medium.

17. An electroluminescent display device, according to claim 16, wherein the electroluminescent display driver activates in response to a diagnostic status condition of the integrated circuit.
- 5
18. An electroluminescent display device, according to claim 1, wherein the electroluminescent medium is silk-screened over the first and second conductors.
19. An electroluminescent display device, according to claim 1, wherein the electroluminescent medium is applied over the first and second conductors using a thin, flexible phosphor-based medium.
- 10
20. A method for manufacturing an electroluminescent display device on a dielectric carrier, comprising:
- 15       applying a first conductive bus having at least one first conductor and a second conductive bus having at least one second conductor in close proximity to said at least one first conductor, over the dielectric carrier and forming at least one area there between;
- depositing a phosphor-based carrier in said at least one area between the first and second conductors, the first and second conductors arranged to excite the phosphors and generate light therefrom; and
- 20       providing a dielectric at a location between the conductors.
21. A method for manufacturing an electroluminescent display device on a dielectric carrier, according to claim 20, wherein applying the first conductive bus includes applying therewith a plurality of first conductors arranged in a pattern.
- 25
22. A method for manufacturing an electroluminescent display device on a dielectric carrier, according to claim 20, wherein applying the first and second conductive buses includes applying therewith a plurality of first conductors and a plurality of second conductors, the first and second conductors interleaving one another to form additional areas, and wherein the phosphor-based carrier is deposited in each of said areas.
- 30
23. A method for manufacturing an electroluminescent display device on a dielectric carrier, according to claim 20, wherein applying includes screen printing.



24. A method for manufacturing an electroluminescent display device on a dielectric carrier, according to claim 20, wherein applying includes removing conductive material from a previously-applied conductor.
- 5 25. An electroluminescent display device, comprising:  
a mirror having a metallized surface selectively etched to define a first conductive bus having at least one first conductor and a second conductive bus having at least one second conductor arranged in close proximity to said at least one first conductor; and  
a phosphor-based carrier including phosphor therein and located proximate to the  
10 first and second conductors to permit an electric field set up by a voltage applied between the first and second conductors to generate light via the phosphor.
26. An electroluminescent display device, according to claim 25, further comprising a dielectric layer disposed between the conductors.
- 15 27. An electroluminescent display device, according to claim 25, wherein the mirror forms part of a liquid crystal display device.
28. An electroluminescent display device, comprising:  
20 a liquid crystal device including a mirror having a metallized surface selectively etched to define a first conductive bus having at least one first conductor and a second conductive bus having at least one second conductor arranged in close proximity to said at least one first conductor; and  
a phosphor-based carrier including phosphor therein and located proximate to the  
25 first and second conductors to permit an electric field set up by a voltage applied between the first and second conductors to generate light via the phosphor.
29. A method for manufacturing an electroluminescent display device on a mirror having a metallized surface, comprising:  
30 selectively etching the metallized surface to define a first conductive bus having at least one first conductor and a second conductive bus having at least one second conductor in close proximity to the at least one first conductor and to form at least one area between at least one first conductor and one second conductor; and  
depositing a phosphor-based carrier having a phosphor in the at least one area, the  
35 first and second conductors arranged to excite the phosphor and generate light therefrom in

response to an applied voltage.

30. A method for manufacturing an electroluminescent display device on a mirror,  
according to claim 29, further comprising providing a dielectric at a location between the  
5 conductors.

31. A method for manufacturing an electroluminescent display device on a mirror,  
according to claim 29, further comprising using a laser to selectively etch the metallized  
surface.

10

32. An electroluminescent display device, comprising:

a dielectric carrier;

a first conductive bus having at least one first conductor and a second conductive  
15 bus having at least one second conductor arranged in close proximity to said at least one  
first conductor, the first and second conductors secured over and supported by the dielectric  
carrier; and

an electroluminescent phosphor-based medium located proximate to the first and  
second conductors to permit an electric field set up by a voltage applied between the first  
20 and second conductors to generate light via the phosphors.

33. An electroluminescent display device, comprising:

a dielectric carrier;

a first conductive bus having at least one first conductor and a second conductive  
25 bus having at least one second conductor arranged in close proximity to said at least one  
first conductor, the first and second conductors secured over and supported by the dielectric  
carrier; and

an electroluminescent polymer medium located proximate to the first and second  
conductors to permit an electric field set up by a voltage applied between the first and  
30 second conductors.

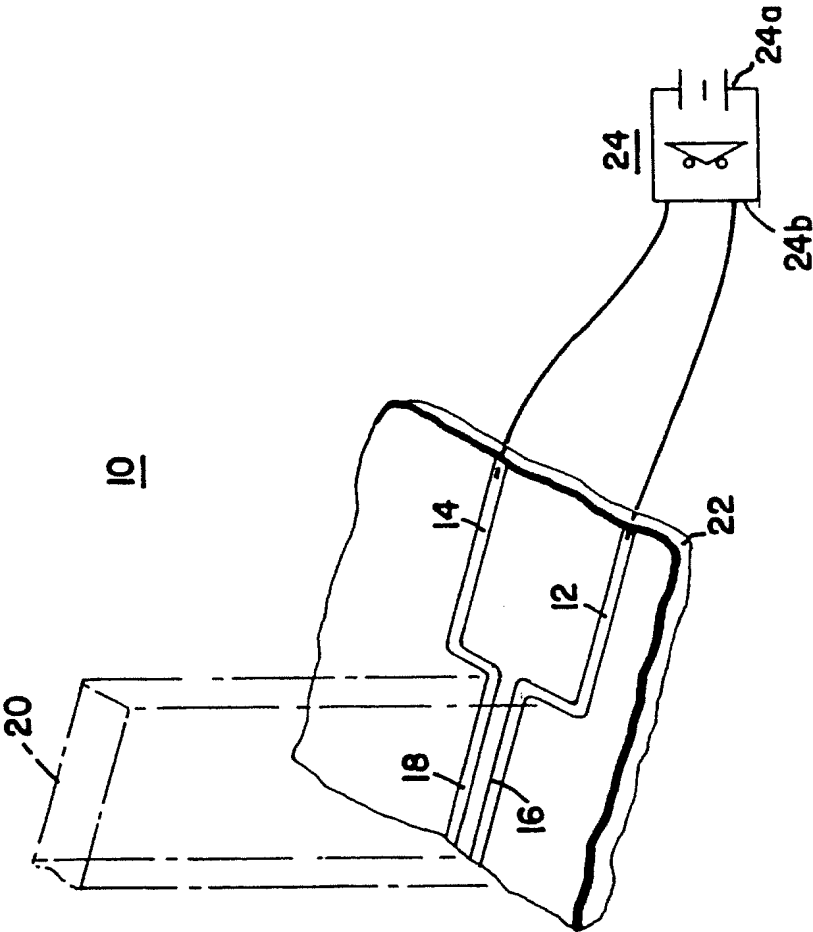
34. A method for making an electroluminescent display, comprising the steps of:

providing a panel having transparent graphic portions;

applying an electroluminescent display device over the panel having conductive

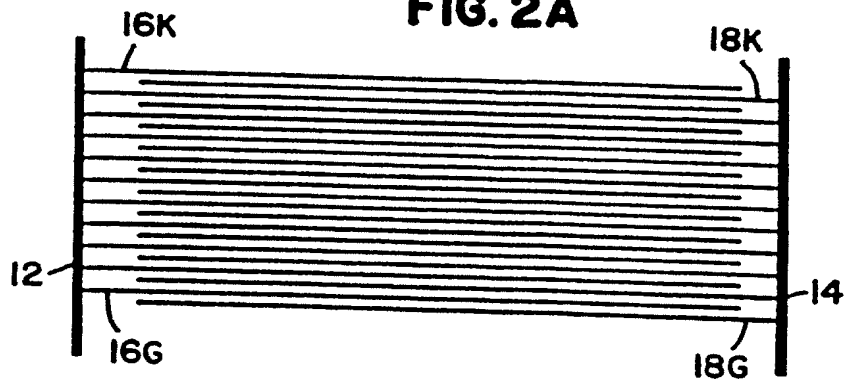
traces in an electroluminescent medium for generating light through the graphic portion; and  
molding plastic that is sufficiently pliable to form a contoured surface over the  
panel.

FIG. 1

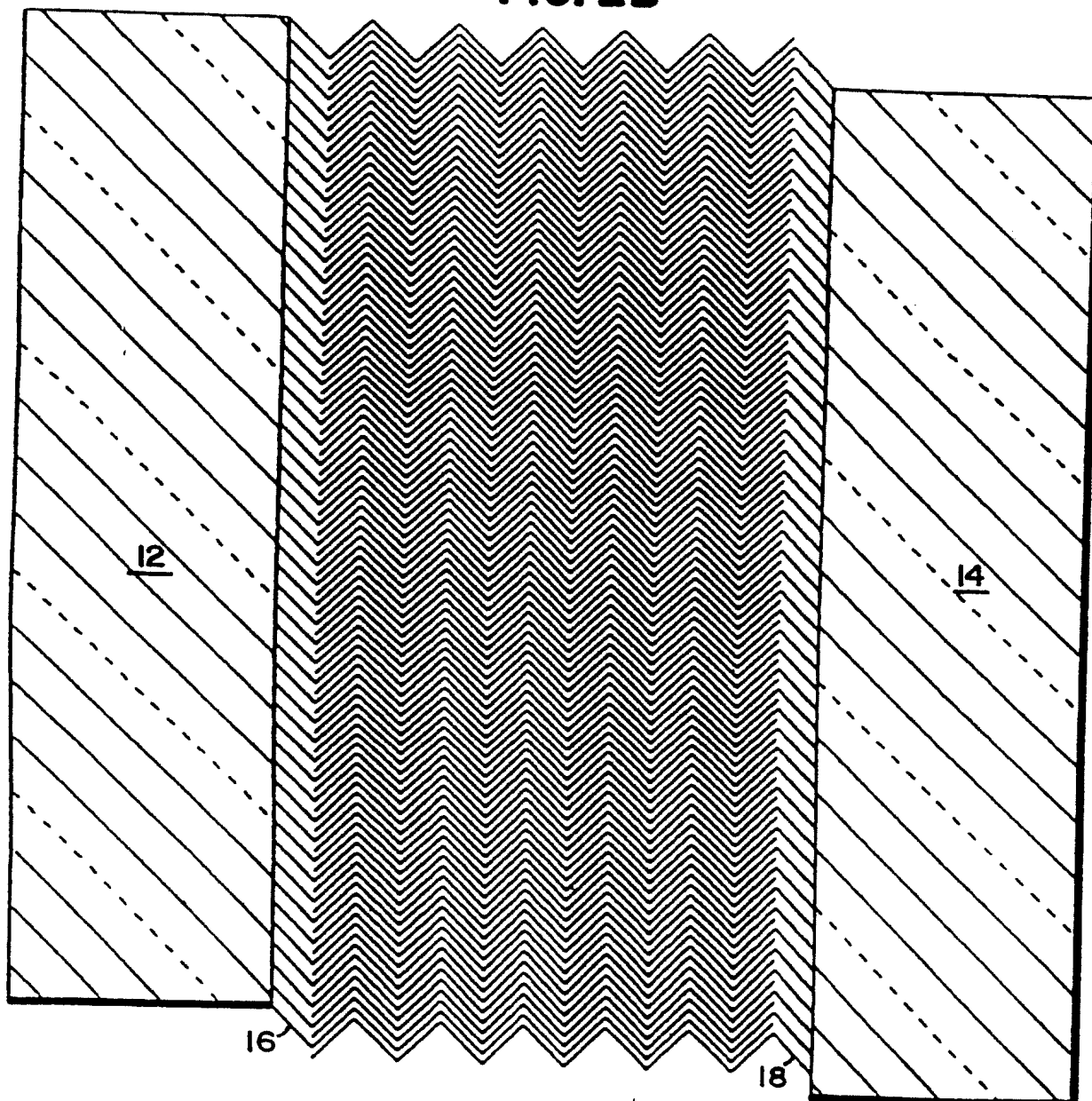


2/8

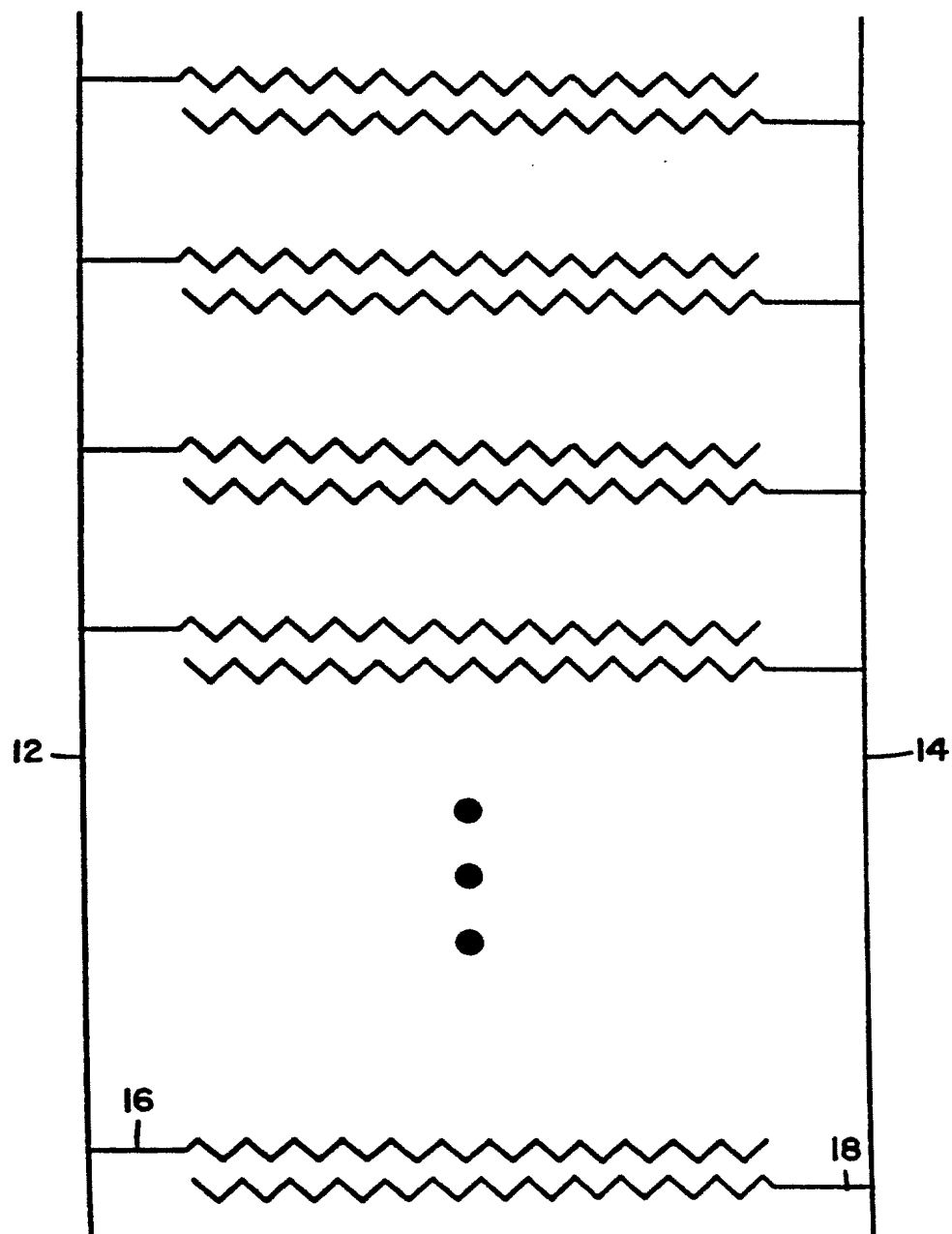
**FIG. 2A**

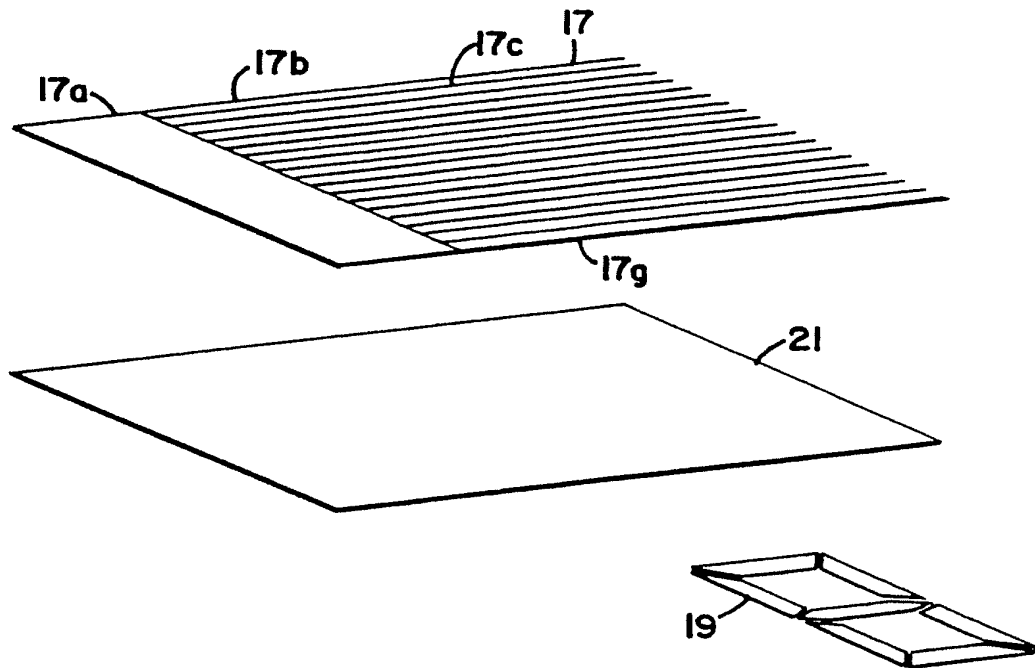


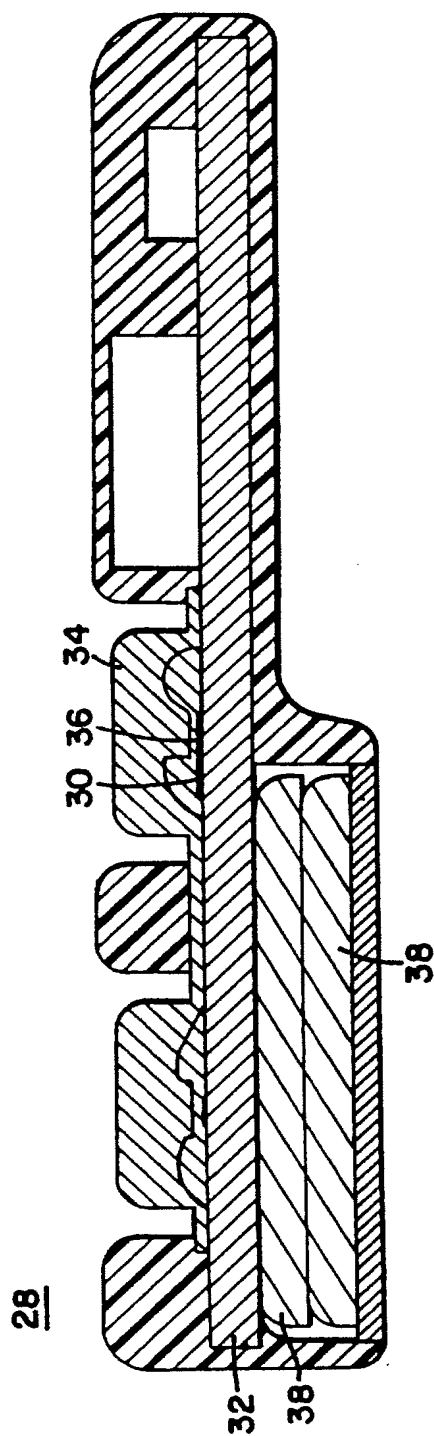
**FIG. 2B**



3/8

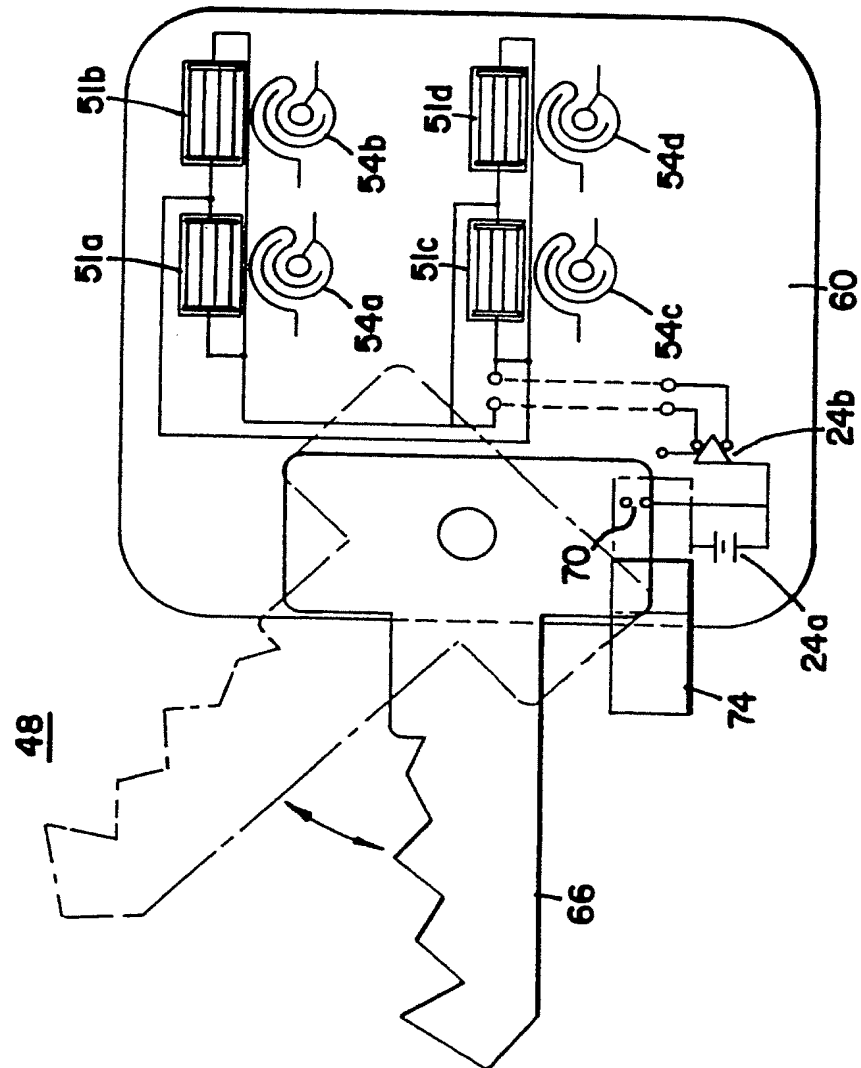
**FIG. 2C**

**FIG. 2D**

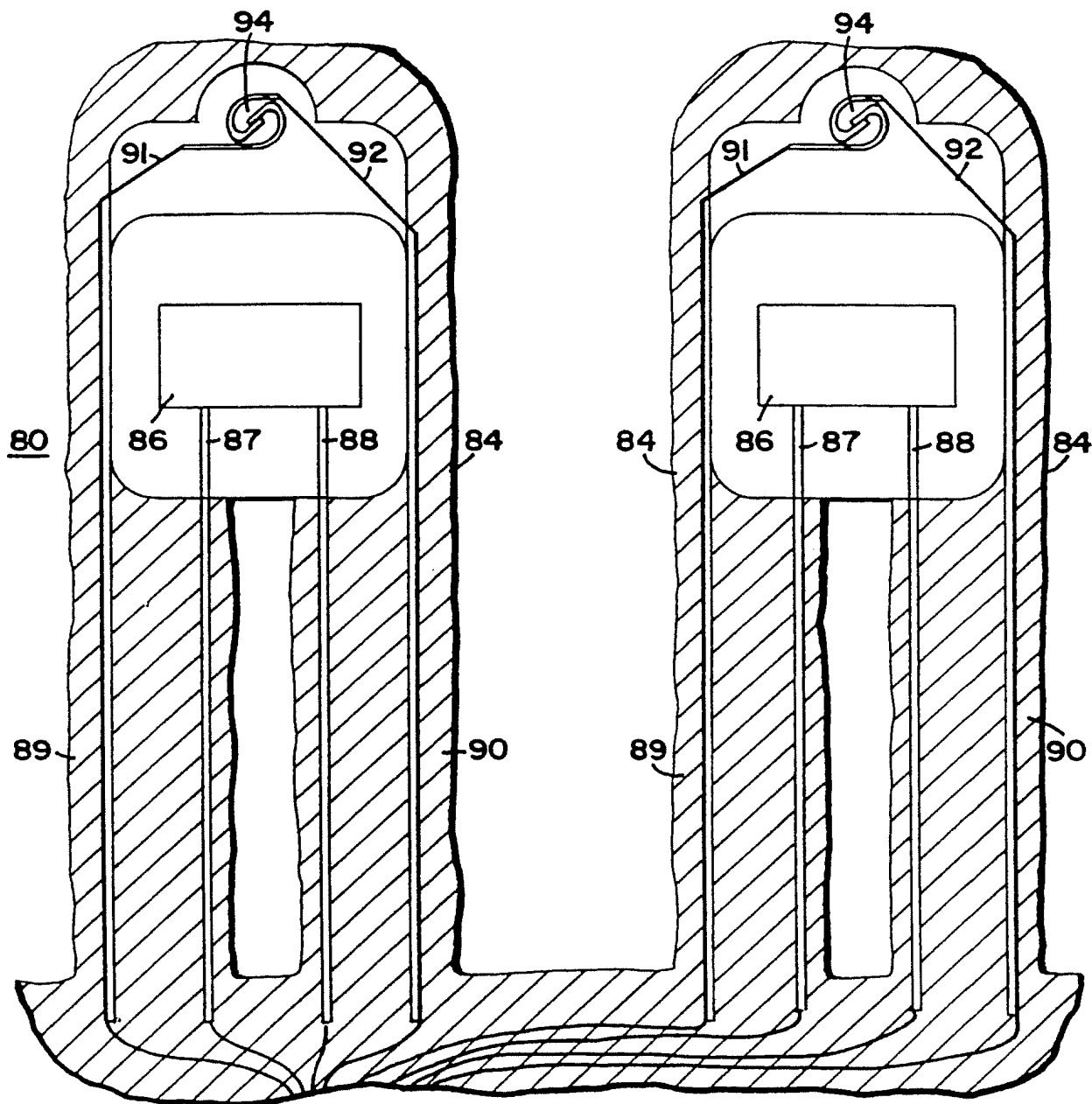
**FIG. 3**



6/8

**FIG. 4**

7/8

**FIG. 5**

8/8

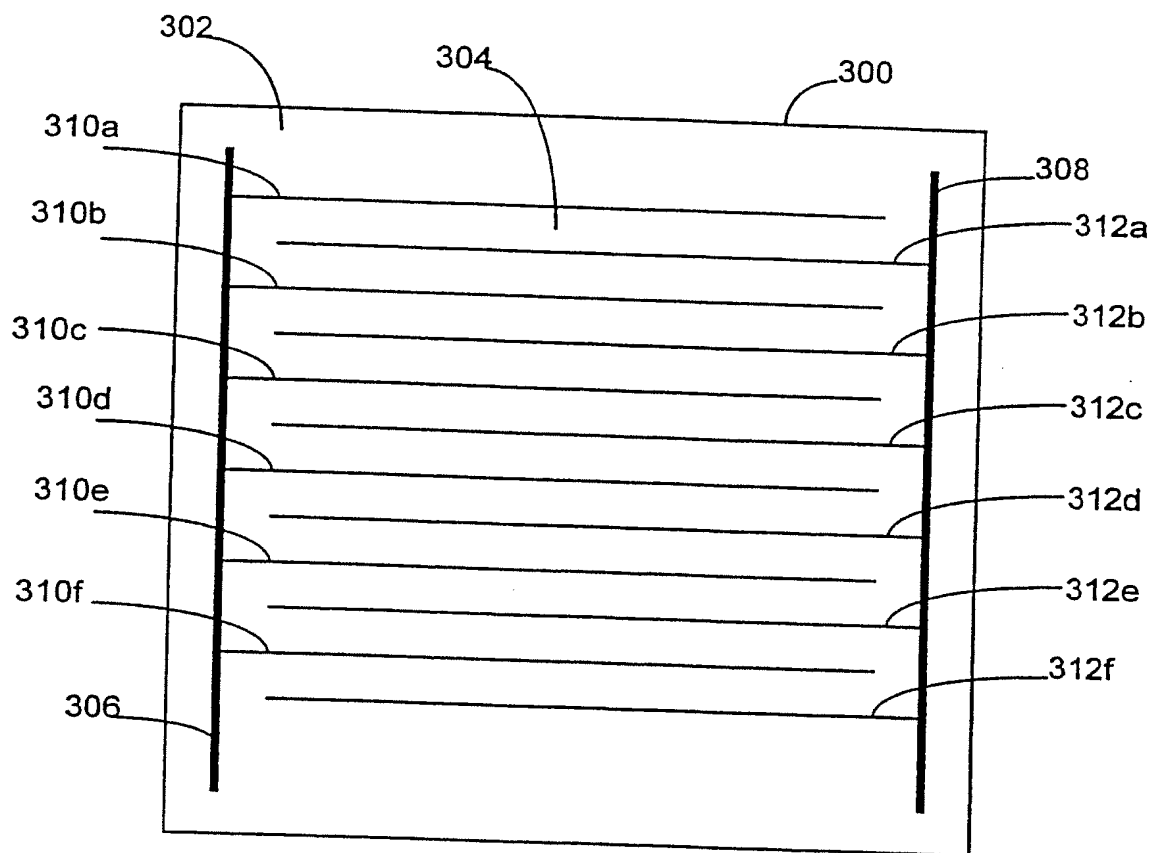


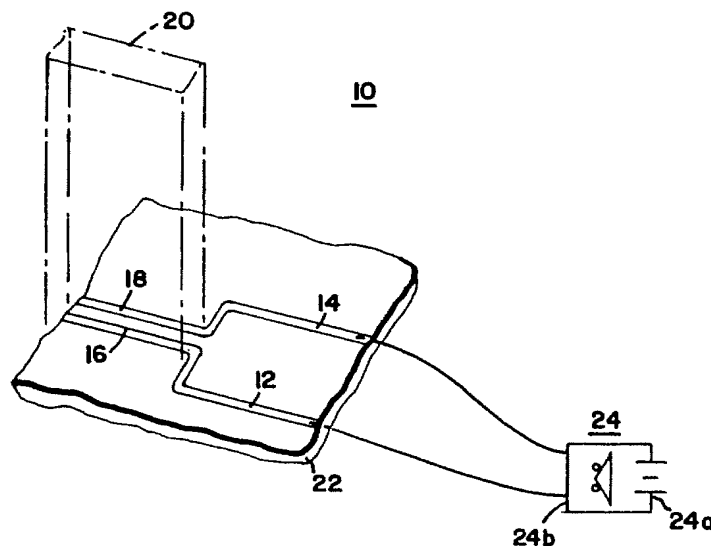
FIG. 6



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>H01J 1/62, B05D 5/06, G09G 3/22</b>		<b>A3</b>	(11) International Publication Number: <b>WO 99/30304</b>
			(43) International Publication Date: 17 June 1999 (17.06.99)
(21) International Application Number: PCT/US98/26111 (22) International Filing Date: 9 December 1998 (09.12.98) (30) Priority Data: 08/988,011 10 December 1997 (10.12.97) US (71) Applicant: PHILLIPS PLASTICS CORPORATION [US/US]; Seven Long Lake Drive, Phillips, WI 54555 (US). (72) Inventors: PETERSON, Francis; 807 College Street, Prescott, WI 54021 (US). WALSH, David; 324 Townsvalley Road, River Falls, WI 54022 (US). (74) Agents: LEVY, Elizabeth, A. et al.; Lappin & Kusmer LLP, 200 State Street, Boston, MA 02109 (US).			(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>  (88) Date of publication of the international search report: 26 August 1999 (26.08.99)

(54) Title: DISPLAY DEVICE AND METHOD THEREFOR



## (57) Abstract

An electroluminescent display (10) includes thin conductive strips on a phosphor-deposited area (20). One aspect of the invention is directed to a device including a dielectric carrier (22) supporting a first conductive bus (12) connecting to first conductors (16) and a second conductive bus (14) connecting to second conductors (18). The first and the second conductors are arranged in close proximity to one another, so that a phosphor based carrier can be located therebetween to permit an electric field set up by voltage applied between the first and the second conductors to generate light via the phosphor. A dielectric layer disposed between the conductors enhances the brightness of the light generated. The electroluminescent display can be incorporated as a part of mirror or liquid crystal device.

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/26111

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : HOI 1/62; B05D 5/06;; G09G 3/22

US CL : 313/510; 427/64; 345/76

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 313/510; 427/64; 345/76, 77, 78, 79, 80; 340/825.52, 825.72

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
APS

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ----- Y	JP 06 104087 A (YASUSHI ET AL) 15 APRIL 1994, see figures 1,3, 5, 7, 9, Abstract, and the attached translation page 6, line 8 through page 7 line 7.	1-3, 8, 11, 18-22, 32, 33 ----- 4-7, 9, 10, 12-17, 23-31, 34
Y	DE 3802317A1 A (GERHARD BECK ET AL.) 03 AUGUST 1989, see the attached english translation page 2, line 13 through page 3, line 15, and figures 1-3.	4-7, 23, 24
Y	US 5,565,733 A (KRAFCIK ET AL) 15 OCTOBER 1996, see column 4, line 34 through column 5, line 47, and figures 1 and 2.	9, 10, 12-17, 34

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	
*A* document defining the general state of the art which is not considered to be of particular relevance	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*B* earlier document published on or after the international filing date	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*O* document referring to an oral disclosure, use, exhibition or other means	*&* document member of the same patent family
*P* document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

02 APRIL 1999

Date of mailing of the international search report

22 JUN 1999

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

Amr Awad

Telephone No. (703) 308-8485

Joni Hill

Form PCT/ISA/210 (second sheet)(July 1992)\*

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/26111

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,574,327 A (CAMMACK et al) 12 NOVEMBER 1996, see column 1, line 35 through line 4, line 51.	25-31

Form PCT/ISA/210 (continuation of second sheet)(July 1992)\*



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US98/26111**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet(1))(July 1992)\*

**BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING**

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

- I. Claims 1-19, drawn to an Electroluminescent display apparatus, and in particular to the way in which the electroluminescent is energized.
- II. Claims 20-24, 29-31, and 34, drawn to a method of manufacturing an electroluminescent display device.
- III. Claims 25-28, and 32-33, drawn to an Electroluminescent apparatus, and in particular to the materials used to illuminate the electroluminescent.

The inventions listed as Groups I, II, and III do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Claims in group I are directed to an Electroluminescent display apparatus and in particular to the way in which the electroluminescent is energized; US classification 345/80.

Claims in group II are directed to a method of manufacturing an electroluminescent display; US classification 427/64.

Claims in group NO. III are directed to an Electroluminescent apparatus and in particular to the material used to illuminate the display; US classification 313/502.